

The ‘System’ of Automobility

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Today, we experience an ease of motion unknown to any prior urban civilization . . . we take unrestricted motion of the individual to be an absolute right. The private motorcar is the logical instrument for exercising that right, and the effect on public space, especially the space of the urban street, is that the space becomes meaningless or even maddening unless it can be subordinated to free movement. (Sennett, 1977: 14)

Automobility and its Self-expansion

ONE BILLION cars were manufactured during the last century. There are currently over 700 million cars roaming the world. World car travel is predicted to triple between 1990 and 2050 (Hawken et al., 1999). Country after country is developing an ‘automobility culture’ with the most significant currently being that of China. By 2030 there may be 1 billion cars worldwide (Motavalli, 2000: 20–1).

Yet strangely the car is rarely discussed in the ‘globalization literature’, although its specific character of domination is more systemic and awesome in its consequences than what are normally viewed as constitutive technologies of the global, such as the cinema, television and especially the computer (see Castells, 2001). In this article I examine what kind of system is automobility, how its character of domination has been exerted, and whether there are any ways in which we might envisage an ending to this systemic domination.

Such an automobility system comprises six components that in their *combination* generate and reproduce the ‘specific character of domination’ that it exercises (see original argument in Sheller and Urry, 2000). Automobility is:

1. the quintessential *manufactured object* produced by the leading industrial sectors and the iconic firms within 20th-century capitalism (Ford, GM, Rolls-Royce, Mercedes, Toyota, VW and so on), and the industry

from which the definitive social science concepts of Fordism and post-Fordism have emerged;

2. the major item of *individual consumption* after housing which provides status to its owner/user through its sign-values (such as speed, security, safety, sexual desire, career success, freedom, family, masculinity); through being easily anthropomorphized by being given names, having rebellious features, seen to age and so on; and which disproportionately preoccupies criminal justice systems (Miller, 2001);
3. an extraordinarily powerful *complex* constituted through technical and social interlinkages with other industries, car parts and accessories; petrol refining and distribution; road-building and maintenance; hotels, roadside service areas and motels; car sales and repair workshops; suburban house building; retailing and leisure complexes; advertising and marketing; urban design and planning; and various oil-rich nations (Freund, 1993);
4. the predominant global form of 'quasi-private' *mobility* that subordinates other mobilities of walking, cycling, travelling by rail and so on, and reorganizes how people negotiate the opportunities for, and constraints upon, work, family life, childhood, leisure and pleasure (Whitelegg, 1997);
5. the dominant *culture* that sustains major discourses of what constitutes the good life, what is necessary for an appropriate citizenship of mobility and which provides potent literary and artistic images and symbols (from E.M. Forster to Scott Fitzgerald to John Steinbeck to Daphne du Maurier to J.G. Ballard: see Bachmair, 1991; Eyerman and Löfgren, 1995; Graves-Brown, 1997).
6. the single most important cause of *environmental resource-use*. This results from the scale of material, space and power used in the manufacture of cars, roads and car-only environments, and in coping with the material, air quality, medical, social, ozone, visual, aural, spatial and temporal pollution of global automobility. Transport accounts for one-third of CO₂ emissions and is indirectly responsible for many 20th-century wars (Adams, 1999; Whitelegg, 1997)

The term 'automobility' captures a double sense, both of the humanist self as in the notion of autobiography, and of objects or machines that possess a capacity for movement, as in automatic and automaton. This double resonance of 'auto' demonstrates how the 'car-driver' is a hybrid assemblage of specific human activities, machines, roads, buildings, signs and cultures of mobility (Thrift, 1996: 282–4). 'Auto' mobility thus involves autonomous humans combined with machines with capacity for autonomous movement along the paths, lanes, streets and routeways of one society after another. What is key is not the 'car' as such but the system of these fluid interconnections. Slater argues that: 'a car is not a car because of its physicality but because systems of provision and categories of things are "materialized" in a stable form', and this generates the distinct affordances that the car provides for the hybrid of the car driver (2001: 6).

In particular it is necessary to consider what stable form or ‘system’ automobility constitutes as it made and remade itself across the globe. We could see this as ‘viral’, emerging first in North America and then virulently spreading into, and taking over, most parts of the body social within pretty well all corners of the globe. Indeed, to some degree, the poorer the country the greater is the power of this virus (see various studies in Miller, 2001).

But I prefer here the formulations of non-linear systems or complexity (see Capra, 1996, 2001; Nicolis, 1995; Prigogine, 1997; Urry, 2003). Automobility can be conceptualized as a self-organizing autopoietic, non-linear system that spreads world-wide, and includes cars, car-drivers, roads, petroleum supplies and many novel objects, technologies and signs. The system generates the preconditions for its own self-expansion. Luhmann defines autopoiesis as:

... everything that is used as a unit by the system is produced as a unit by the system itself. This applies to elements, processes, boundaries, and other structures and, last but not least, to the unity of the system itself. (1995: 3; see Mingers, 1995)

In the next section it is shown how automobility produces through its capacity for self-production, what is ‘used by a unit as a unit’. It is through automobility’s restructurings of time and space that it generates the need for ever more cars to deal with what they both presuppose and call into existence.

This system of automobility stemmed from the path-dependent pattern laid down from the end of the 19th century. Once economies and societies were ‘locked in’ to what I conceptualize as the steel-and-petroleum car, then huge increasing returns resulted for those producing and selling the car and its associated infrastructure, products and services (see Arthur, 1994, on increasing returns). Social life more generally was irreversibly locked in to the mode of mobility that automobility generates and presupposes. This mode of mobility is neither socially necessary nor inevitable but has seemed impossible to break from (but see below). From relatively small causes an irreversible pattern was laid down and this ensured the preconditions for automobility’s self-expansion over the past astonishing century, surely, if we want to give it a name, the ‘century of the car’.

I now examine automobility’s exceptional power to remake time-space, especially because of its peculiar combination of flexibility and coercion. It is this remaking that has ensured the preconditions for its own self-expansion.

But I consider in the following section some small changes that might tip the car system into a different direction, changes that through their dynamic interdependence could provoke a shift beyond automobility, beyond the steel-and-petroleum car, towards a new system of mobility. I term this potentially emergent system the ‘post-car’. I employ the language of path-dependence, increasing returns, emergence and tipping points to examine these complex system changes.¹

Automobility and Time-space

Automobility has irreversibly set in train new socialities, of commuting, family life, community, leisure, the pleasures of movement and so on.² The growth in automobility has principally involved new movement and not the replacement of public transport by the car (Adams, 1999; Vigar, 2002: 12). David Begg of the UK Centre for Integrated Transport definitively notes that: 'Most car journeys were never made by public transport. The car's flexibility has encouraged additional journeys to be made' (quoted in Stradling, 2002). These new mobilities result from how the car is immensely flexible *and* wholly coercive.

Automobility is a source of freedom, the 'freedom of the road'. Its flexibility enables the car-driver to travel at any time in any direction along the complex road systems of western societies that link together most houses, workplaces and leisure sites (and are publicly paid for). Cars extend where people can go to and hence what they are literally able to do. Much 'social life' could not be undertaken without the flexibilities of the car and its 24-hour availability. It is possible to leave late by car, to miss connections, to travel in a relatively time-less fashion.

But this flexibility is necessitated by automobility. The 'structure of auto space' (Freund, 1993; Kunstler, 1994) forces people to orchestrate in complex and heterogeneous ways their mobilities and socialities across very significant distances. The urban environment has 'unbundled' territorialities of home, work, business and leisure that historically were closely integrated, and fragmented social practices in shared public spaces (SceneSusTech, 1998). Automobility divides workplaces from homes, producing lengthy commutes into and across the city. It splits homes and business districts, undermining local retail outlets to which one might have walked or cycled, eroding town-centres, non-car pathways and public spaces. It separates homes and leisure sites often only available by motorized transport. Members of families are split up since they live in distant places involving complex travel to meet up even intermittently. People inhabit congestion, jams, temporal uncertainties and health-threatening city environments, as a consequence of being encapsulated in a domestic, cocooned, moving capsule.

Automobility is thus a system that *coerces* people into an intense *flexibility*. It forces people to juggle fragments of time so as to deal with the temporal and spatial constraints that it itself generates. Automobility is a Frankenstein-created monster, extending the individual into realms of freedom and flexibility whereby inhabiting the car can be positively viewed and energetically campaigned and fought for, but also constraining car 'users' to live their lives in spatially stretched and time-compressed ways. The car is the literal 'iron cage' of modernity, motorized, moving and domestic.

Automobility develops 'instantaneous' time to be managed in complex, heterogeneous and uncertain ways. Automobility involves an individualistic

timetabling of many instants or fragments of time. The car-driver thus operates in instantaneous time rather than the official timetabling of mobility that accompanied the railways in the mid-19th century. This was modernist clock-time based upon the public timetable. As a car-driver wrote in 1902: ‘Traveling means utmost free activity, the train however condemns you to passivity . . . the railway squeezes you into a timetable’ (cited in Morse, 1998: 117). The objective clock-time of the modernist railway timetable is replaced by personalized, subjective temporalities, as people live their lives in and through their car(s) (if they have one). This produces a reflexive monitoring of the self. People try to sustain ‘coherent, yet continuously revised, biographical narratives . . . in the context of multiple choices filtered through abstract systems’ such as automobility (Giddens, 1991: 6). Automobility coerces people to juggle fragments of time to assemble complex, fragile and contingent patterns of social life, patterns that constitute self-created narratives of the reflexive self. Automobility thus produces desires for flexibility that so far only the car is able to satisfy.³

The seamlessness of the car journey makes other modes of travel inflexible and fragmented. So-called public transport rarely provides that kind of seamlessness (except for first-class air travellers with a limousine service to and from the airport). There are many gaps between the various mechanized means of public transport. These ‘structural holes’ in semi-public space are sources of inconvenience, danger and uncertainty. And this is especially true for women, children older people, those who may be subject to racist attacks, the less abled and so on (SceneSusTech, 1998).

As personal times are de-synchronized from each other, so spatial movements are synchronized to the rhythm of the road. The loose interactions and mobilities of pedestrians give way to the tightly controlled mobility of machines, that (hopefully!) keep on one side of the road, within lanes, within certain speeds, following highly complex sign-systems and so on. Driving requires ‘publics’ based on trust, in which mutual strangers are able to follow such shared rules, communicate through common sets of visual and aural signals, and interact even without eye-contact in a kind of default space or non-place available to all ‘citizens of the road’ (see Lynch, 1993). Car-drivers are excused from normal etiquette and face-to-face interactions with all those others inhabiting the road. Adorno wrote as early as 1942: ‘And which driver is not tempted, merely by the power of the engine, to wipe out the vermin of the street, pedestrians, children and cyclists?’ (1974: 40). Car-travel interrupts the taskscapes of others (pedestrians, children going to school, postmen, garbage collectors, farmers, animals and so on), whose daily routines are obstacles to the high-speed traffic cutting mercilessly through slower-moving pathways and dwellings. Junctions, roundabouts, and ramps present moments of carefully scripted inter-car-action during which non-car users of the road constitute obstacles to the hybrid car-drivers intent on returning to their normal cruising speed, deemed necessary in order to complete the day’s complex tasks in time. To inhabit the roads of the west is to enter of world of anonymized machines,

ghostly presences moving too fast to know directly or especially to see through the eye.

Simmel is relevant here. He considers that the eye is a unique 'sociological achievement' (cited in Frisby and Featherstone, 1997: 111). Looking at one another is what effects the connections and interactions of individuals. Simmel terms this the most direct and 'purest' interaction. It is the look between people (what we now call 'eye-contact') which produces extraordinary moments of intimacy since: '[o]ne cannot take through the eye without at the same time giving'; this produces the 'most complete reciprocity' of person to person, face to face (Frisby and Featherstone, 1997: 112). What we see in the person is the lasting part of them, 'the history of their life and . . . the timeless dowry of nature' (Frisby and Featherstone, 1997: 115). Simmel further argues, following notions of the possessive gaze, that the visual sense enables people to take possession, not only of other people, but also of diverse objects and environments, often from a distance (Frisby and Featherstone, 1997: 116). The visual sense enables the world of both people and objects to be controlled from afar, combining detachment and mastery. It is by seeking distance that a proper 'view' is gained, abstracted from the hustle and bustle of everyday experience.

Automobility precludes both of these achievements of the eye. Especially for the non-car-user roads are simply full of moving, dangerous iron cages. There is no reciprocity of the eye and no look is returned from the 'ghost in the machine'. Communities of people become anonymized flows of faceless ghostly machines. The iron cages conceal the expressiveness of the face and a road full of vehicles can never be possessed. There is no distance and mastery over the iron cage; rather, those living on the street are bombarded by hustle and bustle and especially by the noise, fumes and relentless movement of the car that cannot be mastered or possessed (see Urry, 2000: ch. 4, on the senses).

More generally, '[M]odernist urban landscapes were built to facilitate automobility and to discourage other forms of human movement. . . . [Movement between] private worlds is through dead public spaces by car' (Freund, 1993: 119). Large areas of the globe consist of car-only environments – the non-places of super-modernity (Augé, 1995; Merriman, 2004). About one-quarter of the land in London and nearly one-half of that in LA is devoted to car-only environments. And they then exert spatial and temporal dominance over surrounding environments, transforming what can be seen, heard, smelt and tasted (the spatial and temporal range of which varies for each of the senses). They are sites of mobility within which car-drivers are insulated as they 'dwell-within-the-car'. They represent the victory of liquidity over the 'urban' (see Morris, 1988, on the motel).

Further, the driver is strapped into a comfortable if constraining armchair and surrounded by micro-electronic informational sources, controls and sources of pleasure, what Williams calls the 'mobile privatisation' (see Pinkney, 1991: 55). The Ford brochure of 1949 declared that 'The 49 Ford is a living room on wheels' (Marsh and Collett, 1986: 11; the

VW camper is described as a ‘Room with a View’). The car is a room in which the senses are impoverished. Once in the car, there is almost no kinaesthetic movement from the driver. So although automobility is a system of mobility, it necessitates minimal movement once one is strapped *into* the driving seat. Eyes have to be constantly on the look-out for danger, hands and feet are ready for the next manoeuvre, the body is gripped into a fixed position, lights and noises may indicate that the car-driver needs to make instantaneous adjustments, and so on. The other traffic constrains how each car is to be driven, its speed, direction, its lane and so on. The driver’s body is itself fragmented and disciplined to the machine, with eyes, ears, hands and feet, all trained to respond instantaneously and consistently, while desires even to stretch, to change position, to doze or to look around are being suppressed. The car becomes an extension of the driver’s body, creating new subjectivities organized around the extraordinarily disciplined ‘driving body’ (see Freund, 1993: 99; Hawkins, 1986; Morse, 1998). A Californian city planner declared as early as 1930 that ‘it might be said that Southern Californians have added wheels to their anatomy’ (cited in Flink, 1988: 143). The car can be thought of as an extension of the senses so that the car-driver can feel its very contours, shape and relationship to that beyond its metallic skin. As Ihde describes: ‘The expert driver when parallel parking needs very little by way of visual clues to back himself into the small place – he “feels” the very extension of himself through the car as the car becomes a symbiotic extension of his own embodiedness’ (1974: 272). An advert for the BMW 733i promised the ‘integration of man and machine . . . an almost total oneness with the car’ (quoted in Hawkins, 1986: 67). The body of the car provides an extension of the human body, surrounding the fragile, soft and vulnerable human skin with a new steel skin, albeit one that can scratch, crumple and rupture once it encounters other cars in a crash (see Brottman, 2001, on ‘car crash culture’). Within the private cocoon of glass and metal intense emotions are released in forms otherwise unacceptable (see Michael, 1988, on road rage).

System Change

Thus far I have characterized the current car system and its general characteristics. It is important to note that there are multiple variations in how the car has been desired and ‘inhabited’ by different social groups,⁴ that there are historical shifts in the ways of inhabiting the car, and that there are significant ‘technical’ changes in the nature of cars.⁵

But what I have suggested is that these multiple desires and forms of inhabiting have produced as unintended effect the expansion of the system of the privately owned and mobilized ‘steel-and-petroleum’ car. Such a car system began in the last decade of the 19th century and then came to dominate contemporary alternatives that may have been preferable (Motavalli, 2000; see Scharff, 1991, on the gendering of these alternative power sources). The ‘path-dependence’ of the petroleum-based car was established and irreversibly ‘locked’ in.

In the 1890s there were three main methods of propelling vehicles: petrol, steam and electric batteries, with the latter two apparently being more 'efficient' (Motavalli, 2000: ch. 1). Petroleum-fuelled cars were established for small-scale, more or less accidental reasons, partly because a petrol-fuelled vehicle was one of only two to complete a 'horseless carriage competition' in Chicago in 1896. The petrol system got established and 'locked' in, and the rest is history so to speak. Thus small causes occurring in a certain order at the end of the 19th century turned out to have irreversible consequences for the 20th century, what we might call the century of the car.

Path-dependence analyses show that causation can flow from contingent events to general processes, from small causes to large system effects, from historically or geographically remote locations to the general (see Mahoney, 2000: 536). Linear models are now savaged both by theorists of non-linear dynamics (Capra, 1996, 2001; Nicolis, 1995; Prigogine, 1997) and by empirically oriented sociologists (see Abbott's tirade against 'generalised linear reality'; 2001). 'Path-dependence' shows that the ordering of events or processes through time very significantly influences the non-linear ways in which they eventually turn out decades or even centuries later. Hence, according to Abbott 'time matters' (2001). Path-dependence is thus a process model in which systems develop irreversibly through a 'lock-in', but with only certain small causes being necessary to prompt their initiation, as with the contingent design of the QWERTY keyboard or the unpredictable origins of the petrol-based car (Arthur, 1994; Mahoney, 2000: 535–6).

The importance of the lock-in means that institutions matter a great deal to how systems develop over longer time periods. Social institutions such as suburban housing, oil companies, out-of-town shopping centres, can have the effect of producing a long-term irreversibility that is 'both more predictable and more difficult to reverse' according to North (1990: 104). The effects of the petroleum car over a century after its relatively chance establishment show how difficult it is to reverse locked-in institutional processes as billions of agents co-evolve and adapt to that remaking of the system of automobility across the globe (see Sheller and Urry, 2000).

Thus in order to break with the current car system, what Adams terms 'business as usual' (1999), we need to examine the possibilities of 'turning points'. Abbott argues that change is the normal order of things and indeed many assessments of contemporary social life emphasize the increasingly accelerating nature of such profound changes. But there are certain networks of social relations that get stabilized for long periods of time, what are often called social structures. One such structure is the car system that is remarkably stable and unchanging, even though a massive economic, social and technological maelstrom of change surrounds it. The car-system seems to sail on regardless, now over a century old and increasingly able to 'drive' out competitors, such as feet, bikes, buses and trains. The car system, we might say, is a Braudelian *longue durée* (Abbott, 2001: 256).

But as Abbott notes, and indeed it is a key feature of complexity approaches to systems, nothing is fixed forever. Abbott maintains that there is: ‘the possibility for a pattern of actions to occur to put the key in the lock and make a major turning point occur’ (2001: 257). Such non-linear outcomes are generated by a system moving across turning or tipping points (Gladwell, 2000). Tipping points involve three notions: that events and phenomena are contagious, that little causes can have big effects, and that changes can happen not in a gradual linear way but dramatically at a moment when the system switches. Gladwell describes the consumption of fax machines or mobile phones, when at a particular moment every office appears to need a fax machine or every mobile ‘cool’ person requires a mobile. Wealth in such a situation derives not from the scarcity of goods as in conventional economics but from abundance (Gladwell, 2000: 272–3).

Current thinking about automobility is characterized by linear thinking: can existing cars can be given a technical fix to decrease fuel consumption or can existing public transport be improved a bit (see Urry, 2003, on non-linearity)? But the real challenge is how to move to a different pattern involving a more or less complete break with the current car system. The current car-system could not be disrupted by linear changes but only by a set of interdependent changes occurring in a *certain* order that might move, or tip, the system into a new path (see Gladwell, 2000; Sheller and Urry, 2000).

I now examine whether a different pattern is indeed emerging, by looking at what may be the seeds of a new system of mobility for the rest of this century. These ‘seeds’ involve not just the technical-economic transformations of different fuel systems and car body materials as argued by Hawken et al. (1999; Motavalli, 2000; US Department of Transportation, 1999). These seeds also involve an array of political, policy and social transformations, a veritable new urbanity. If they were to develop in optimal order within the next decade or so, then the break with current automobility might just be effected through their systemic interdependencies.

There are six technical-economic, policy and social transformations that in their dynamic interdependence might tip mobility into a new system, the post-car (see Graham and Marvin, 2001, for a different view). First, there are new *fuel systems* for cars, vans and buses including batteries, especially lead acid and nickel metal hydride, hybrid cars powered by diesel and batteries, and hydrogen or methanol fuel cells. There may be a tipping point when suddenly large numbers of consumers move over to one of these alternative vehicles that, like the mobile phone, suddenly overnight seems the cool way to be mobile. A contagion suddenly takes place (see Motavalli, 2000: 107, on developments by Toyota, BMW, Honda, Ford, Daimler-Chrysler, Volvo, PSA, Shell, BP). At the same time there is increasing uncertainty of oil supplies following 11 September 2001, which exposed the US’s dependence upon Middle Eastern oil. Some predict large increases in petrol prices and a heightened uncertainty of supplies that also could also help to tip the system (Motavalli, 2000).

Second, there are various *new materials* for constructing 'car' bodies. Especially significant is the Lovins ultra-light 'hypercar' made of advanced polymer composite materials. Other technologies include aluminium and nanotechnology which may make possible carbon-based fibres 100 times stronger than steel at one-sixth the weight (Hawken et al., 1999; US Department of Transportation, 1999: 4–5). Each of those can very significantly reduce the weight of vehicles and hence the need for powerful engines to move them. Also, there may be increasing production of much smaller micro-cars (rather than four-person family-sized cars) for crowded urban spaces. Examples of such micro-cars or 'station cars' include the Mercedes Smart Car, the Cabriolet, the Nissan Hypermini, BMW's motor cycle/car hybrid the C1, the ULTra automated taxis in Cardiff activated by a smart card, the Taxi2000 urban transit solution, and PSA's TULIP car.⁶

Third, there is the development of 'smart-card' *technology* that could transfer information from car to home, to bus, to train, to workplace, to web site, to shop-till, to bank. Vehicles are increasingly hybridized with the technologies of the mobile, personal entertainment system and laptop computer (as car companies join up with ISPs). Car-drivers and passengers may be personalized with their own communication links (email addresses, phone numbers, web addresses: Gow, 2000) and entertainment applications (digitally stored music, programmed radio stations). Thus any vehicle is becoming more of a 'smart home' away from home (as with the new Range Rover). This connectivity could facilitate a single means of paying for 'travel' whatever the form of transport and simultaneously help to de-privatize so-called cars that become more like portals.

Fourth, cars more generally are being *de-privatized* through car-sharing, car clubs and car-hire schemes. Six hundred plus cities across Europe have developed car-sharing schemes involving 50,000 people (Cervero, 2001). Prototype examples are found such as Liselec in La Rochelle, and in northern California, Berlin and Japan (Motavalli, 2000: 233). In Deptford there is an on-site car pooling service organized by Avis attached to a new housing development, while in Jersey electric hire cars have been introduced by Toyota. On occasions this de-privatization will involve smart-card technology to book and pay and also to pay fares on buses, trains or more demand-responsive collective buses or mini-vans (as with the Newcastle Nexus). A further prototype of this is the E-Taxi system in Dublin. These developments reflect the general shift in contemporary economies from ownership to access, as shown more generally by many services on the Internet (see Rifkin, 2000). So we could hypothesize the increasing payment for 'access' to travel/mobility services rather than the owning of vehicles outright. One important consequence is that if car users were not to own cars then car manufacturers would be responsible for short-term car parking and for long-term disposal of 'dead' vehicles (see Hawken et al., 1999, on how this could radically improve recycling rates).

Fifth, *transport policy* is shifting away from predict-and-provide models based on seeing increased mobility as a desirable good and in which

predictions of future car use were planned for through new road schemes developed by engineers. These schemes provided what had been predicted in the model (Vigar, 2002; Whitelegg, 1997). Increasingly, ‘new realist’ policies see the expansion of the road network as not neutral but as increasing car-based travel. The focus of policy moves to changing driver behaviour through demand-reduction strategies, although this is difficult without heavy coercion or marketized inducements (Kaufmann, 2000). The new realism involves many organizations developing alternative mobilities through computer-mediated intermodality, integrated public transport, better facilities for cyclists and pedestrians, advanced traffic management, better use of land-use planning, real-time information systems and a wider analysis of how transport impacts upon the environment (Vigar, 2002).

Finally, *communications and the Internet galaxy* are increasingly interconnected with transportation (see Castells, 2001). There is the embedding of information and communication technologies (ICT) into moving objects: mobile phones, palmheld computers, cars, buses, trains, aircraft and so on. As information is digitized and released from location, so cars, roads and buildings are re-wired to send and receive digital information (as with ‘Intelligent Transport Systems’). Thus emerging technologies are grafting together existing machines to create new hybrid mobilities. At the same time face-to-face connections may be increasingly simulated, at least with broadband connectivity, and hence may reduce the need for travel. Computer-mediated communications at home or in the office, or especially on the move, may reduce the frequency of travelling. But further, the very distinction between on-line and off-line may dissolve as connections between people become complex combinations of face-to-face co-present encounters, unscheduled get-togethers, dyadic telephone calls, emails to one person or several, and online discussions among those with shared interests (Beckmann, 2004; Laurier, 2004; Urry, 2002; Wellman, 2001).

So there are six sets of changes that I have briefly outlined. None of them is sufficient in themselves to tip the car system into new channels. But my proposal is that their interdependencies occurring in an optimal order might thus provoke the emergence of a post-car system. A series of small changes now might produce a sense of contagion as many changes sweep through the system.

This system of the ‘post-car’, commencing in some societies in the rich ‘north’ (Iceland perhaps, which has recently announced itself as the first hydrogen economy) would consist of multiple, dense forms of movement including small, light, smart, probably hydrogen-based, de-privatized ‘vehicles’ electronically and physically integrated (seamlessly) with many other forms of mobility. In this post-car system there will be a mixed flow of slow-moving semi-public micro-cars, bikes, many hybrid vehicles, pedestrians and mass transport integrated into a mobility of physical *and* virtual access. Electronic tolls will regulate access, price and speed. Neighbourhoods will foster ‘access by proximity’ through denser living patterns and integrated land use. Systems will promote electronic coordination between

motorized and non-motorized transport, and between those 'on the move' in many different ways (Hawken et al., 1999: 47; Sheller and Urry, 2000). The cool way of travelling will not be to own but to access small, light mobile pods when required.

Conclusion

Complexity is thus the starting point for examining how this global system that seems so unchangeable, may through small changes, if they occur in a certain order, tip it into a post-car mobility system. Complexity approaches emphasize three points about such a shift away from the current car system.

First, the pattern of 19th-century 'public mobility', of the dominance of buses, trains, coaches and ships, will not be re-established. That has been irreversibly lost because of the self-expanding character of the car system that has produced and necessitated individualized mobility based upon instantaneous time, fragmentation and coerced flexibility. Any post-car-system will substantially involve the individualized movement that automobility presupposes and has simultaneously brought into being as an irreversible consequence of the century of the car.

Second, the days of steel and petroleum automobility are numbered. By 2100 it is inconceivable that individualized mobility will be based upon the 19th-century technologies of steel-bodied cars and petroleum engines. A tipping or turning point will occur during the 21st century, when the steel and petroleum car system will finally be seen as a dinosaur (a bit like the Soviet empire, early freestanding PCs or immobile phones). When it is so seen then it will be dispatched for good and no one will comprehend how such a large, wasteful and planet-destroying creature could have ruled the earth. Suddenly, the system of automobility will disappear and become like a dinosaur, housed in museums, and we will wonder what all the fuss was about.

Third, this tipping point is unpredictable. It cannot be read off from linear changes in existing firms, industries, practices and economies. Just as the Internet and the mobile phone came from 'nowhere', so the tipping point towards the 'post-car' will emerge unpredictably. It will probably arrive from a set of technologies or firms or governments that are currently not a centre of the car industry and culture, as with the Finnish toilet paper maker Nokia and the unexpected origins of the now ubiquitous mobile phone.⁷ And this will have happened by the end of this century. Predicting when exactly this will happen is impossible, although this article has argued that the categories of complexity are the way to examine how such possibilities may develop and intersect, and how a system that seems utterly intractable now may one day just turn over and die.

Notes

1. For more detail on this mode of analysis within the social sciences, see Urry (2003). Also see Capra (2001).
2. For more detail on the following section, see Sheller and Urry (2000).

3. Baudrillard particularly captures some of the characteristics of driving in *America* (1988). He describes the empty landscapes of the desert that are experienced through driving huge distances across them; travel involves a ‘line of flight’. Deserts constitute a metaphor of endless futurity, a primitive society of the future, combined with the obliteration of the past and the triumph of time as instantaneous rather than time as depth (1988: 6). Driving across the desert involves leaving one’s past behind, driving on and on, seeing the ever-disappearing emptiness framed through the windscreen.

4. It should of course be noted that women appear to inhabit cars somewhat distinctly. The automobilization of family life not only brought the newest and most expensive car models first to male ‘heads of families’, while women had to settle for second-hand models or smaller cars, but also led to the uneven gendering of time-space. While working men became enmeshed in the stresses of daily commuter traffic into and out of urban centres, suburban ‘housewives’ had to juggle family time around multiple, often conflicting, schedules of mobility epitomized by ‘the school run’. Once family life is centred within the moving car, social responsibilities tend to push women, who now drive in very significant numbers, towards desiring ‘safer’ cars and ‘family’ models, while men often indulge in individualistic fantasies of the fast sports car, the 4WD or the impractical ‘classic car’. Cars were originally designed to suit the average male body and have only recently been designed to be adjustable to drivers of various heights and reaches. The distribution of company cars has also benefited men more than women, due to continuing horizontal and vertical segregation in the job market, which keeps most women out of private sector positions with access to such ‘perks’. However, actuarial statistics show that male drivers are more likely to externalize risks onto others through a much greater tendency to speeding, and hence to maiming and killing others (see Meadows and Stradling, 2000). Women drivers are statistically not bad drivers.

5. The various papers in this *TCS* collection bring out many of these social, historical and cultural variations.

6. Although other commentators might well point to the counter-tendency of the recent exceptional growth of SUVs.

7. Hence my only slightly tongue-in-cheek comment about Iceland, which is currently seeking to run all of its buses on hydrogen fuel cells.

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